RESEARCH DEPARTMENT

POLARISATION DISCRIMINATION OF RECEIVING AERIALS AT V.H.F.

Report No. K-106

(1955/31)

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SUMMARY

When the polarisations of the receiving aerial and the transmitted wave are at right angles, the voltage induced in the aerial is theoretically zero. In practice, the orthogonal relation may not be maintained, and a voltage may be present in the aerial.

In this report two further experiments are described, designed to measure the ratio between the induced voltages when the polarisation of the receiving aerial is in the plane of the transmitting aerial, and at right angles to it. The results confirm that a discrimination of at least 10 dB may be expected at all times, when the polarisations are crossed.

1. INTRODUCTION.

When the number of channels available for planning a nation-wide television service is limited, the avoidance of co-channel interference becomes a problem of major importance. The range of a transmitter as a source of interference far exceeds its useful range. Care must therefore be exercised in siting the transmitters and in fixing the power radiated, so that the maximum service may be provided with the minimum probability of interference. By placing transmitters working on the same frequency at widely separated points, and by limiting the power radiated to the minimum required to serve their respective areas, a large measure of protection against co-channel interference is obtained. This protection is increased if the two transmissions are cross-polarised.

The purpose of the experiments described was to determine the magnitude of the increased protection. An earlier experiment[1] over a path 120 miles (193 km) long indicated that an improvement of at least 10 dB could be expected. The present tests were made over longer paths, to discover whether protection deteriorated with distance as a result of any rotation of the plane of polarisation during propagation.

2. FIRST EXPERIMENT. MEASUREMENTS AT KINGSWOOD.

The transmission used in this experiment was the vertically polarised signal from Holme Moss on a frequency of 51·75 Mc/s. The distance between Holme Moss and Kingswood Warren is 174 miles (280 km). The duration of the experiment was 10th December to 29th December 1952.

2.1. Apparatus.

Two Hallicrafter receivers, modified to indicate signal strength on a recording milliammeter, were each coupled to one section of a duplex recorder and calibrated against a signal generator. The test aerials consisted of two half-wave dipoles with reflectors mounted at right-angles to each other, with their centres coincident. The vertical elements were taken to one of the receivers, the horizontal to the other. A simultaneous record of the voltage output of each aerial was thus obtained.

The two aerials were checked for sensitivity and found to be identical. They were, however, not calibrated for field strength, and the measurements taken were in terms of voltage at the receiver input. The apparatus was installed on an open site, remote from buildings and reasonably distant from trees. The aerials were 30 ft (9·2 m) above ground level.

2.2. Results.

The signals received on the horizontal dipole were at most times too small to deflect the recording meter. The ratio of the horizontal voltage (E_h) to the vertical (E_v) could only be calculated for those occasions, ranging in duration from one to ten minutes, when there was clear evidence of signal on the "horizontal" record. Table 1 gives the number of such occasions against the dates on which they occurred.

TABLE 1

Date	No. of Occasions
December 1952	
10th	1
11th	4
15th	2
16th	1
18th	8
19th	4
22nd	1
23rd	7
27th	2
29th	3

The dots in Fig. 1 represent the values of E_h/E_v plotted against E_v for all the occasions tabulated. They lie very close to the curve, which has been drawn to the equation

$$E_h = 1{\cdot}8 + 0{\cdot}03\,E_v$$

The signal on the horizontal aerial may in consequence be treated as composed of two parts:

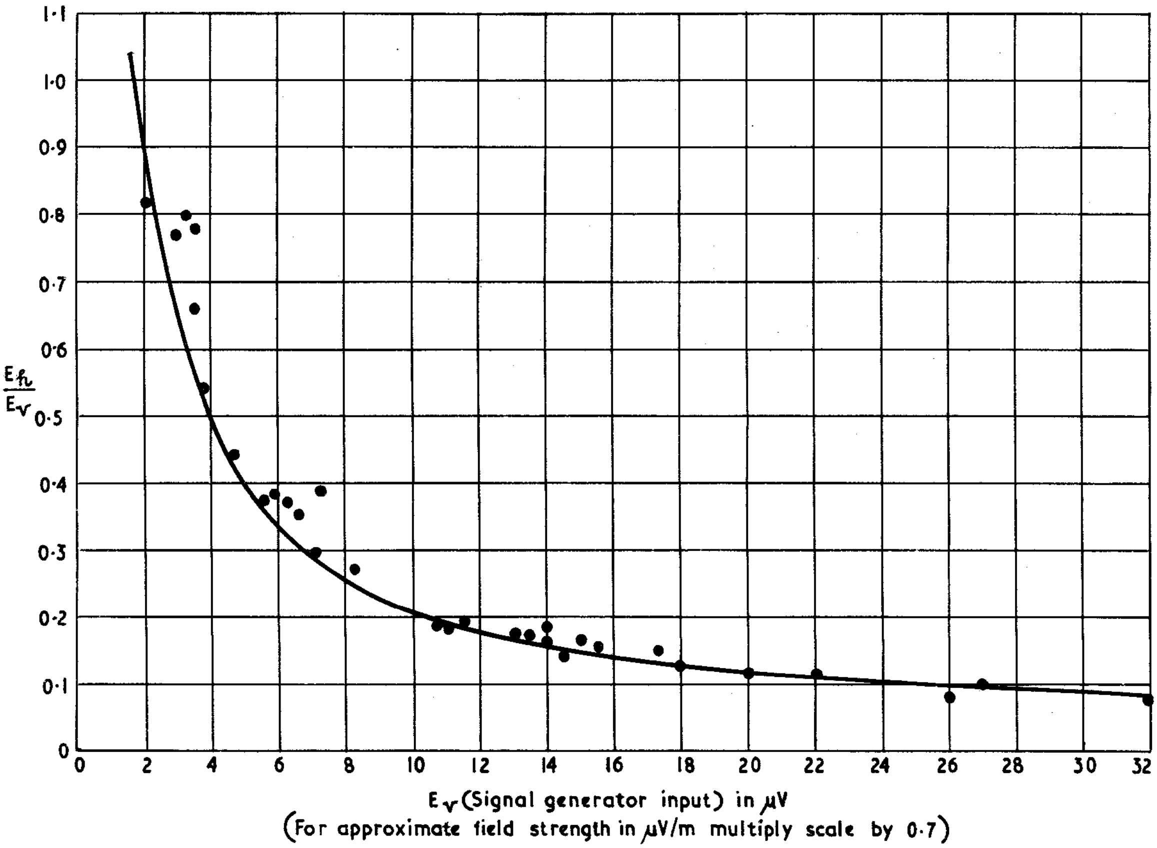

Fig. 1 - Holme Moss HP/VP tests at Kingswood. Records taken from 10/12/52 to 29/12/52

i. A steady voltage equivalent to 1·8μV at the receiver input.

ii. A varying voltage whose magnitude is always 3% of the voltage output of the vertical aerial, equivalent to a discrimination of 30 dB.

The steady voltage represents ambient noise. The constancy of the 3% ratio between the horizontal and vertical voltages suggests that the limit of discrimination of the system is reached at this figure.

A tolerance of only 1·6° in the construction or erection of the aerial could account for this limit, not unreasonable in the apparatus used.

2.3. Conclusion.

It is concluded that no change occurred in the polarisation of the transmitted signal over the path of 174 miles (280 km) during the period of the tests. The high ratio of 30 dB recorded in this case is due to the absence of scattering objects near the aerial, and such ratios may reasonably be expected on other similar sites.

3. SECOND EXPERIMENT. FIELD MEASUREMENTS.

Tests were carried out at three sites at different distances from the Wrotham transmitter, using the horizontally polarised signal on 93·8 Mc/s.

3.1. Apparatus.

A half-wave dipole which could be rotated smoothly through 360° by remote control was mounted on the mobile laboratory, and raised to a height of 30 ft (9·2 m) for the tests.

The output of the aerial was carried by a screened balanced cable to the balanced input of an HR8 receiver, thus reducing the possibility of error due to stray pick-up on the feeder.

The system was checked on an open site at a distance of 25 miles (40 km) from Wrotham. With the aerial in the vertical position, a discrimination of better than 30 dB was obtained.

3.2. Technique of Measurement.

The tests were carried out at the fixed sites of the long distance propagation experiment, where the transmission from Wrotham was being continuously recorded.

The mobile equipment was set up as close as practicable to the aerial of the fixed site. With the rotatable dipole in the horizontal position, the mobile equipment was calibrated against that of the fixed site which, throughout the tests, was used as a control.

The measurements were made with the rotatable dipole in the vertical position. Recordings of signal strength were taken on both receivers and the records analysed. In the case of two of the sites the median values were compared. At the time of measuring at the third site (Harrogate), signals were weak, and the ratios calculated are for the quasi-peaks.

3.3. Results.

Table 2 gives the results of these tests. The sites, though not entirely clear, were reasonably free from trees or conducting objects, and might be described as rural.

TABLE 2

Site	Distance from Transmitter		Height above sea level		Duration of Recording	E_h/E_v
	Miles	km	ft	m		
Nottingham	137	221	470	143	142 minutes	−13·5 dB
Harrogate	206	330	512	156	236 minutes	−22 dB *
Newcastle	281	453	480	146	66 minutes	−10·5 dB

* Ratio of quasi-peaks

3.4. Conclusions.

In the E_h/E_v ratios tabulated, no allowance has been made for ambient noise. Moreover, it is not possible to assess the magnitude of the noise component in these tests since only a single figure (median or quasi-peak) is available for each site.

It is clear from the results, however, that even assuming noise to be absent, the discrimination to be obtained by crossing polarisations of reception and transmission is better than 10 dB.

No correlation with distance is apparent in the ratios, since the greatest discrimination obtained relates to the middle of the three distances tested. It may therefore be assumed that the protection ratio is independent of distance.

4. REFERENCE.

1. B.B.C. Research Department Report No. K-081, "Observations at Kingswood Warren of the Reception of Sutton Coldfield on Vertical and Horizontal Receiving Aerials".